

AD-A214 695

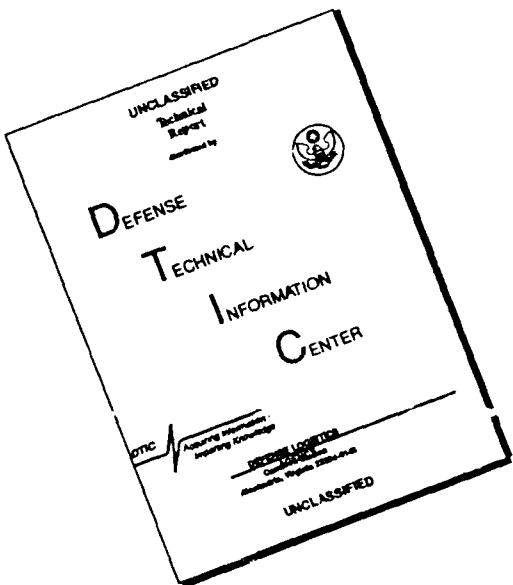
REPORT DOCUMENTATION PAGE			Form Approved OMB NO. 0704-0188
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1200, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</p>			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
	July 1979	Final	
4. TITLE AND SUBTITLE		5. FUNDING NUMBERS	
INVERSE SCATTERING: IONOSPHERIC STRUCTURE DETERMINATION		61102F 2304/A4	
6. AUTHOR(S)			
Jeffrey M. Cohen			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION REPORT NUMBER	
University of Pennsylvania Department of Physics Philadelphia, Pennsylvania 19104		APPROV. NO.: 89-1413	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
AFOSR BLDG 410 BAFB DC 20332-6448		AFOSR 78-3608	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)			
14. SUBJECT TERMS		15. NUMBER OF PAGES 9	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

NSN 7540-01-280-5500

Standard Form 298 (890104 Draft)
 Prescribed by ANSI Std. Z39-18
 298-01

89 11 2. 093

DISCLAIMER NOTICE.



**THIS DOCUMENT IS BEST
QUALITY AVAILABLE. THE COPY
FURNISHED TO DTIC CONTAINED
A SIGNIFICANT NUMBER OF
PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

AFCOSR-78-3608

100-77-2

Inverse Scattering: Ionospheric Structure Determination

Jeffrey M. Cohen
Physics Department
University of Pennsylvania
Philadelphia, Pennsylvania 19104

July 1979
Final Technical Report
for period 1 July 1978 to 30 June 1979

Approved for public release

Air Force Office of Scientific Research
Directorate of Mathematical and Information Sciences
Bolling Air Force Base
Washington, D.C. 20332

Table of Contents

1. Accomplishments under AFOSR Grant 78-3608 for the period
1 July 1978 to 30 June 1979
 - 1.1 Papers and Lectures
 - 1.2 Research Objectives which have been Accomplished
 - 1.3 Interaction with Other Investigators



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution	
Availability Codes	
Dist	Avail. Codes
A-1	Special

1. Accomplishments under AFOSR Grant 78-3608 for the period

1 July 1978 to 30 June 1979

1.1 Papers and Lectures

a. Curved Space Scattering.

- i. Invited paper presented at Conference on Mathematical Methods and Applications of Scattering Theory,
21-25 May 1979
- ii. to be published by Springer-Verlag.

1.2 Research Objectivities which have been Accomplished.

During the time of the present grant, all mathematical machinery and computer codes necessary to determine the ionospheric structure via the exact fall wave theory have been developed and tested on synthetic models. Some of this work is described below.

Accurate time delay and phase shift data is obtainable with presently available ionosonds. To obtain the reflection coefficient $b(k)$ from the phase $\varphi(k)$ we used the analytic properties of $b(k)$ and developed a generalized form of the Hilbert transform which allows the amplitude $\text{Re}[\ln(b(k))] = \ln|b(k)| = w(k)$ to be calculated from the phase via the relation

$$\ln|b(k)| = \frac{p}{\pi} \int_{-\infty}^{\infty} \frac{k(\varphi(k') - 2z_0 k') dk'}{k'(k' - k)} .$$

Here p indicates a principle value and z_0 is the height above the ionosphere to the bottom of the ionosphere. It was necessary to develop this generalized version of the transform because of the particular analytical properties of $b(k)$. The complete reflection coefficient follows via $b(k) = \exp[\ln|b(k)| + i\varphi(k)]$.

The transform was verified analytically for particular cases. For any analytic function $f(z) = R(z) e^{i(\varphi(z) + \alpha z)}$ we showed that the amplitude follows via

$$\ln R(z) = \ln R(0) + \frac{p}{\pi} \int_{-\infty}^{\infty} \frac{z[\varphi(z') - \alpha z] dz}{z'(z' - z)} .$$

For ionospheric scattering, $R(0) = 1$ and thus $\ln R(0)$ vanishes.

For this transform, a computer program (which takes into account the singular structure of the integrand) was developed and tested on various analytic synthetic scattering data where exact results are known. Below the computed amplitude and phase results for one and two δ -function potentials is compared with the known analytic results. The accuracy of the computer calculation can be set in advance by choosing a parameter.

Although any desired accuracy can be obtained subject only to computer precision chosen, six place accuracy was used for the synthetic example. As can be seen from the printout, the precision is greater than six-places in all cases. The reason for such accuracy is that when real data is used, all errors will be due to inaccuracies in the data. Furthermore, computer codes for (1) the Gelfand-Levitan integral equation and (2) a fast Fourier transform have been developed, coded, debugged, tested against synthetic models and found to work well. Initially, noise will be filtered from the data by taking a running average of various numbers of experimental data values. If desirable, more complicated filtering methods for noise reduction will be instituted later. Thus all necessary computer codes are debugged and available for immediate use as soon as the ionosond data becomes available.

Besides this, a manuscript describing our method has been

prepared. This manuscript by Cohen and Moses which is a more detailed version of Section I of this proposal, will be submitted shortly. Also both Cohen and H. E. Moses have presented invited papers at the conference on scattering sponsored by NRL and held in May, 1979.

卷之三

۲۶

۲۷۸

55.	1	4-1745 6 450
56.	2	-4-1397 6 700
57.	3	-4-1397 6 700
58.	4	-4-1397 6 700
59.	5	-4-1397 6 700
60.	6	-4-1397 6 700
61.	7	-4-1397 6 700
62.	8	-4-1397 6 700
63.	9	-4-1397 6 700
64.	10	-4-1397 6 700
65.	11	-4-1397 6 700
66.	12	-4-1397 6 700
67.	13	-4-1397 6 700
68.	14	-4-1397 6 700
69.	15	-4-1397 6 700
70.	16	-4-1397 6 700
71.	17	-4-1397 6 700
72.	18	-4-1397 6 700
73.	19	-4-1397 6 700
74.	20	-4-1397 6 700
75.	21	-4-1397 6 700
76.	22	-4-1397 6 700
77.	23	-4-1397 6 700
78.	24	-4-1397 6 700
79.	25	-4-1397 6 700
80.	26	-4-1397 6 700
81.	27	-4-1397 6 700
82.	28	-4-1397 6 700
83.	29	-4-1397 6 700
84.	30	-4-1397 6 700
85.	31	-4-1397 6 700
86.	32	-4-1397 6 700
87.	33	-4-1397 6 700
88.	34	-4-1397 6 700
89.	35	-4-1397 6 700
90.	36	-4-1397 6 700
91.	37	-4-1397 6 700
92.	38	-4-1397 6 700
93.	39	-4-1397 6 700
94.	40	-4-1397 6 700
95.	41	-4-1397 6 700
96.	42	-4-1397 6 700
97.	43	-4-1397 6 700
98.	44	-4-1397 6 700
99.	45	-4-1397 6 700
100.	46	-4-1397 6 700
101.	47	-4-1397 6 700
102.	48	-4-1397 6 700
103.	49	-4-1397 6 700
104.	50	-4-1397 6 700
105.	51	-4-1397 6 700
106.	52	-4-1397 6 700
107.	53	-4-1397 6 700
108.	54	-4-1397 6 700
109.	55	-4-1397 6 700
110.	56	-4-1397 6 700
111.	57	-4-1397 6 700
112.	58	-4-1397 6 700
113.	59	-4-1397 6 700
114.	60	-4-1397 6 700
115.	61	-4-1397 6 700
116.	62	-4-1397 6 700
117.	63	-4-1397 6 700
118.	64	-4-1397 6 700
119.	65	-4-1397 6 700
120.	66	-4-1397 6 700
121.	67	-4-1397 6 700
122.	68	-4-1397 6 700
123.	69	-4-1397 6 700
124.	70	-4-1397 6 700
125.	71	-4-1397 6 700
126.	72	-4-1397 6 700
127.	73	-4-1397 6 700
128.	74	-4-1397 6 700
129.	75	-4-1397 6 700
130.	76	-4-1397 6 700
131.	77	-4-1397 6 700
132.	78	-4-1397 6 700
133.	79	-4-1397 6 700
134.	80	-4-1397 6 700
135.	81	-4-1397 6 700
136.	82	-4-1397 6 700
137.	83	-4-1397 6 700
138.	84	-4-1397 6 700
139.	85	-4-1397 6 700
140.	86	-4-1397 6 700
141.	87	-4-1397 6 700
142.	88	-4-1397 6 700
143.	89	-4-1397 6 700
144.	90	-4-1397 6 700
145.	91	-4-1397 6 700
146.	92	-4-1397 6 700
147.	93	-4-1397 6 700
148.	94	-4-1397 6 700
149.	95	-4-1397 6 700
150.	96	-4-1397 6 700
151.	97	-4-1397 6 700
152.	98	-4-1397 6 700
153.	99	-4-1397 6 700
154.	100	-4-1397 6 700

**BEST
AVAILABLE COPY**

SCATTERING FROM 2 DELTA FUNCTIONS. COMPARISON OF VALUES OF LOG(MULTITUDE) VIA INTEGRAL TRANSFORM
 (NUMERICAL) OR VIA EXACT ANALYTIC RESULT

x_0	NUMERICAL	ANALYTIC	x_0	NUMERICAL	ANALYTIC
1.0	-1.4705307490-01	-1.4787374040-01	2.0	-1.4449654860-00	-1.4449654860-00
3.0	-5.3701946101-01	-6.3742010103-01	6.0	-1.0741502000-00	-1.0741502000-00

1.3 Interaction with Other Investigators

a. We have participated in the Inverse Scattering Seminar at the Courant Institute of Mathematical Sciences organized by Prof. Peter Lax.

b. We have discussed informally problems of mutual interest concerning inverse scattering theory with Professors Peter Lax, Percy Deift, Louis Nirinberg, and Trubowitz at the Courant Institute. Extensive interaction between the members of the research group has taken place including direct and telephone conversation between the Penn and Lowell contingents.